Finite Element Analysis Visualization and Data Management

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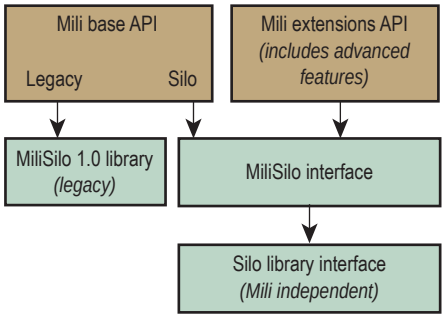
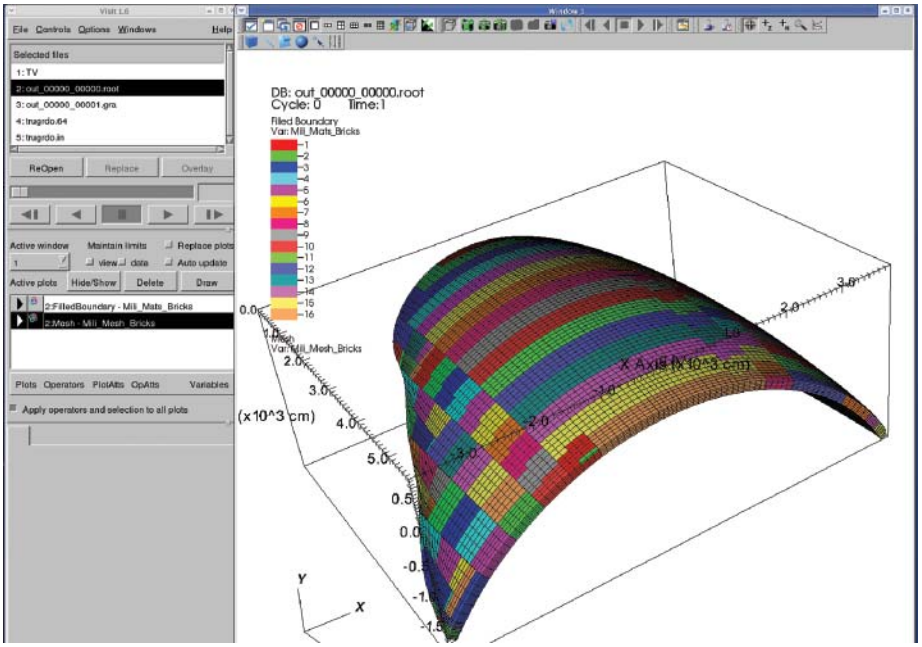


Figure 1. Mili 1.0 and 2.0 API hierarchy.

A key component of our project is its support for post-processing and visualization tools, including the Griz finite element visualization post-processor, the Mili data management library, and a data utility tool called Xmilics. These tools are used by analysts and engineers across LLNL to interpret data from a variety of simulation codes such as DYNA3D, ParaDyn, NIKE3D, TOPAZ3D and Diablo.

Griz is our primary tool for visualizing finite element analysis results on 2- and 3-D unstructured grids. Griz provides advanced 3-D visualization techniques such as isocontours and isosurfaces, cutting planes, vector field display, particle traces, and free-particles or free-node approaches. Mili is a high-level mesh I/O library intended to support computational analysis and post-processing on unstructured meshes. It provides the primary data path between analysis codes and Griz. Mili databases are also viewable with the LLNL VisIt post-processor.

Figure 2. Engineering model as viewed in VisIt and generated from new Mili/Silo Library.



Xmilics is a utility used to combine results that are generated by our large parallel computing platforms.

Project Goals

The project provides ongoing support for visualization and post-processing tools and adds new capabilities to these tools to support evolving, multi-programmatic requirements.

Relevance to LLNL Mission

These post-processing tools provide important user interfaces for our simulation capabilities and are critical elements in our tool suite. Analysts would otherwise be severely limited in their ability to interpret the vast amounts of data generated by simulations, and to synthesize key results.

FY2007 Accomplishments and Results

User support continues to be a high-priority goal. The group is currently supporting approximately 30 to 40 active users on a variety of platforms across LLNL and some off-site users, including LANL. This year we saw a high level of usage and special requests from users and a higher number of analysts using Griz and VisIt concurrently to meet their needs.

We made significant progress in migrating Mili to a modern file structure. We defined and documented the requirements. We then created a useful model, choosing the LLNL-supported Silo format, because of its application programming interface (API) and its compatibility with the VisIt visualization tool. The architecture is hierarchical with a separation between the Silo and Mili layers (Fig. 1). Both new and legacy interfaces are maintained in one library to provide backward compatibility and reduce the migration impacts to our simulation codes. Figure 2 shows an example of a model written using

the new Mili/Silo format and rendered directly with VisIt without a conversion utility. This is one example of our ongoing effort to integrate Mili database support directly with VisIt.

We added a variety of new visualization features to Griz, with the most significant being: 1) a capability to render models in wireframe mode and a combination of wireframe and solid (Fig. 3); 2) a capability to render materials with undefined results in grayscale (Fig. 4); 3) the capability to generate JPEG and PNG graphic files on nearly all Griz-supported platforms; and 4) the ability to use Griz on the new Windows platforms.

Collaboration continued with exploring "meshless" techniques having an unstructured cloud of particles with no continuum elements. The results are treated in Griz in much the same way as the "free-node" capability delivered in FY2006 to support the Department of Homeland Security. This year we added capabilities to plot any typically nodal or hex result, such as displacements, onto their associated particles (Fig. 5), and to select individual particles and view a result. Software quality engineering efforts expanded to include the use of a commercial tool to create a baseline assessment of potential defects.

FY2008 Proposed Work

We will continue to provide support for our user base. Efforts targeted for next year include: 1) releasing the Mili/Silo Library for general usage with streamlined connections to VisIt; 2) adding support for higher-order elements to Mili and Griz; 3) completing the static analysis of Griz for potential defects and performing the same analysis for Mili; and 4) implementing automated regression testing for Mili.

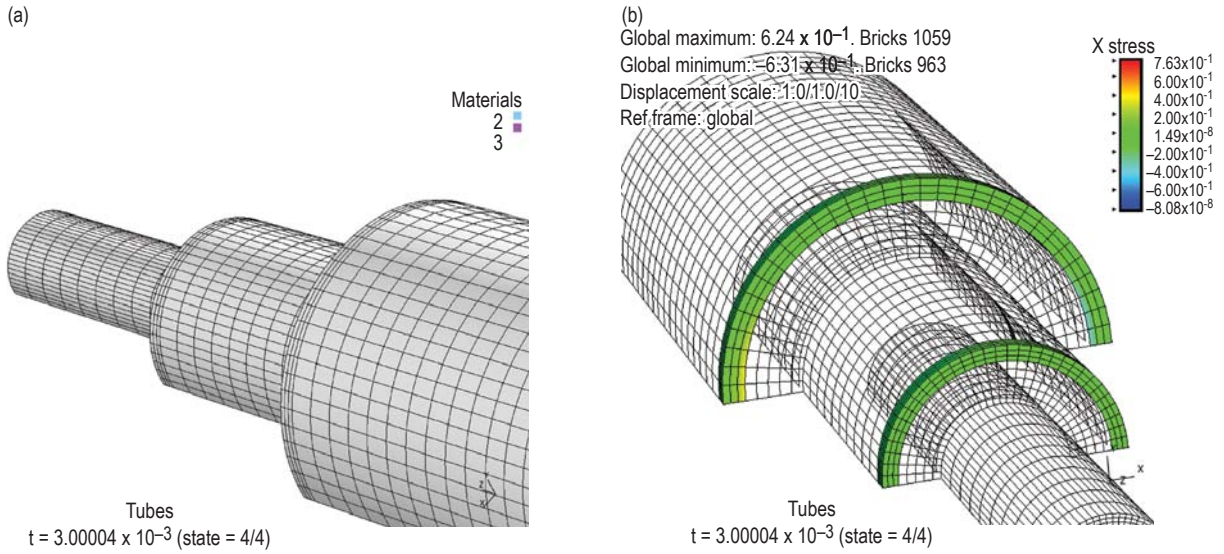


Figure 3. (a) Rendering of model in wireframe mode. (b) Example of wireframe and solid rendering mode.

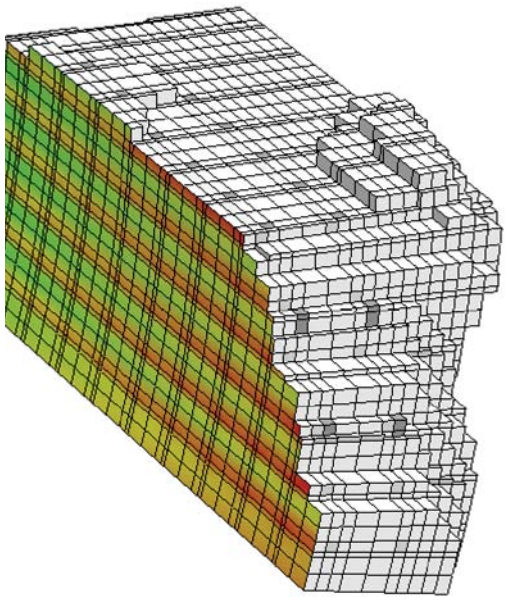


Figure 4. Rendering of results with inactive materials as grayscale.

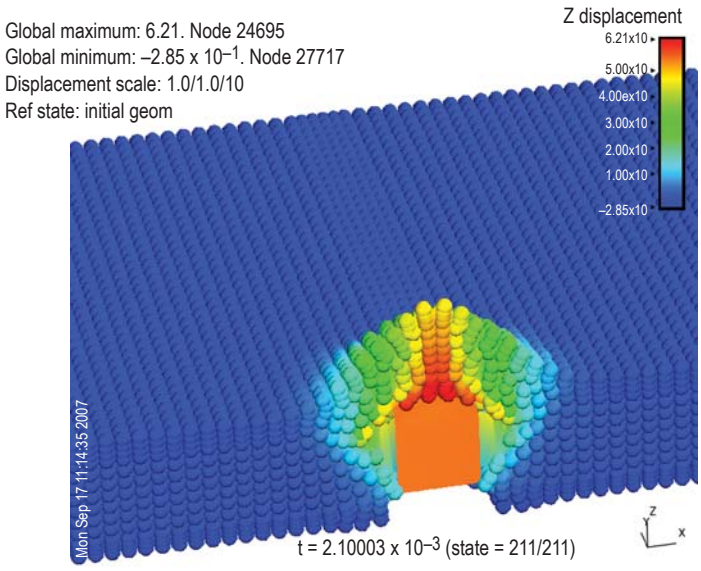


Figure 5. Example of plotting nodal displacement result onto particles.